Talk at Harden Foundation Mill in Salinas, California, for SPOOM visitors to California

November 7, 2015

Title: **Grist for the Mill – Grains for your health**

Summary
The grist of the Western World is wheat.
Watching the flour fall from the stones of a 4 inch granite stone mill. Red wheat vs white wheat; hard wheat vs soft wheat
Nutritional value of all the parts of the wheat grain: bran, germ and endosperm.
Why vegetarians have hard time with wheat.
Wheat agriculture the way it is and the way it could be
Is localization the solution to our wheat problems?

Good evening everyone and thank you for the introduction.

The most usual grist for my mill has been wheat. Occasionally I have milled corn and teff. The grist I'll be talking about today is wheat. I have found no reason to dispute its contribution to the most successful ancient and modern civilizations in the Western hemisphere. In my view the problems we are seeing today are due to the way in which we deal with wheat, which from the 1890s onwards have been drastically different to the practices that were in use previously, both in the way we mill wheat into flour and the way we treat it agriculturally.

I have been the happy owner of an 8-inch granite stone mill from Meadows Mills, since 1984, and a member of SPOOM for a good deal of that time. However, recently I've acquired a 4 inch granite stone mill made by the Jansen family, and have loaned out my 8 inch mill, in the hope of finding converts to freshly ground whole wheat flour. With this new small mill I can watch the flour fall into a container, and it makes a white cone of the endosperm flour, with the bran and germ particles falling down the sides. The bran is dark colored from red wheat and spelt, creamy colored from white and durum wheat. And the bran comes in large flakes from soft grains and fine flakes from hard grains. It's a signal that I need to mix the flour to make it uniform for baking, but it's also a signal that all parts of the grain are not equal.

The white endosperm is mainly starch and gluten protein. If you've ever chewed on a handful of wheat grains, as the farmer does in their wheat field, you'll know that you can chew everything away except a chewing gum like mass, which is the gluten protein from the endosperm. Cooking the gluten makes it digestible, as good protein food. Bread structure is dependent on the gluten, and the starch, in the endosperm of wheat. However from the point of view of the plant: the wheat grain is a seed. The endosperm starch is stored energy food, and the proteins include enzymes that can release this energy and make structural material for the plant to grow. But none of this will happen without the materials that are in the bran, and germ. Similarly people miss out in their bread if they do not also eat the bran, and germ.

The germ, from where the grain sprouts, contains protein, although not of the kind that gives bread dough its characteristic texture. Wheat germ is particularly rich in essential oils, and vitamin E, also known as tocopherol, which translates from Greek to mean the vitamin associated with child bearing. Vitamin E was discovered to be vital to healthy reproduction. The germ also contains the B-vitamin known as folic acid, which in humans prevents the devastating spinal deformity in babies known as spina bifida. Also in wheat germ there are substantial amounts of the B-vitamins thiamin, riboflavin and niacin, and a good supply of mineral compounds: hardly any sodium, but plenty of potassium, some calcium and magnesium, phosphorus, iron and zinc. The plant needs these vitamins and minerals to activate the enzymes, which in turn release energy and make new materials for the developing plant. Importantly people also need these vitamins and minerals to properly release energy from the digestible carbohydrate foods: starch and sugars that we eat. Eaten alone in a white cake or soft drink, without enough B-vitamins and minerals, these digestible carbohydrates are not fully assimilated and cause the formation of fat instead of the expected energy. The reason we have so called enriched flour, is to make sure that a selection of these vitamins and minerals are present with the endosperm white flour, otherwise we would be suffering from gross deficiency diseases as people did, before the presence of vitamins and their role in foods was understood, by the 1940s. Actually some compensation for the lack of these vitamins and minerals can be found when we eat non-plant foods: milk, fish and meat. Thus vegetarians would be at risk if the flour was not enriched in this way, and the poor subsisting on little else other than bread would be the first to manifest signs of these deficiency diseases.

The bran of the wheat grain is structurally made up of cellulose, which is a completely indigestible type of carbohydrate. Even the bacteria in the intestines can't digest it, so it is valuable as a carrier for our food, and carrier for the waste that must eventually be eliminated. This is known as insoluble dietary fiber, and is will flow all the way through our digestive tract until it is eliminated. Also in the bran there are layers of fiber that resist digestion with the normal digestive juices, but which will be digested by the intestinal bacteria. This is known as soluble dietary fiber. Indeed soluble fiber is essential to maintaining a flourishing intestinal microflora, or microbiome as they now call it. It is valuable not only for feeding the microbiome, but because we absorb the products from the microbiome into our system and one result is the favorable lowering of low density cholesterol. In the sourdough bread system this soluble dietary fiber, often in the form of pentosans, is partially broken down so offering an improvement to the whole grain bread texture. Bread made with modern baker's yeast would not have this capacity to improve the whole grain dough. The aleurone layer just underneath the bran is rich in protein, including enzyme protein, although not of the kind that gives bread its characteristic texture. This layer is rich in B-vitamins, and minerals and is also part of the system necessary for the seed to become a plant. At the same time we as humans benefit from these compounds.

Then there are the other compounds in the bran layer that for years were treated as unwanted. I'm talking about the tannins, which in the plant repel insects if they are strongly enough flavored. By now these tannins have been named in detail and redefined as powerful antioxidants. These are the main flavor and color compounds in wheat. It is these antioxidant polyphenolic compounds in the bran that help to make the bran instrumental in reducing the incidence of colon cancer, and offering protection against diabetes. These are all similar to the polyphenolics in fruits and vegetables that are famous for also having these particular protective effects. If you are eating all your wheat in the whole grain form this is equivalent to eating fruits and vegetables, except of course for the effect of vitamin C in such fruits as oranges and the carotenes in carrots.

Having dissected and appreciated that the wheat grain is at its best for us in the whole gain form. Let's now consider wheat as a seed and the agriculture of wheat.

In the late 1800s the German botanist Gregor Mendel developed the laws of heredity in plants, and set the stage for a new age of plant breeding. Prior to Mendel, making crosses between wheat plants in the hope of producing an interesting new variety was something of a gamble. New varieties of wheat were mostly the result of a farmer finding an interesting variant in their field and growing it out until there was enough available for breadmaking, and for other farmers to grow. We have just such a variety that has been grown again in California; it is Foisy wheat selected by the Frenchman Mr Foisy in Oregon, in 1865, and named after him by all those around him, who enjoyed growing it. Anyway, since about 1900 wheat breeders have been bent on improving wheat; meaning by this, to make it suitable for roller milling by making sure it is hard and red like the famous Turkey Red from Kansas or the Red Fife wheat from Canada. The roller millers like this hardness so that when the grain goes through the first step in the milling process, and is moistened the bran is easily and completely removed, without the grain becoming mushy. When breeders produced hard wheat, for regions previously good for growing soft wheat, new disease susceptibility arose. They also had to breed for resistance to disease. Always however, they were aiming for higher yielding wheat to impress the farmer. Basically every region was provided with wheat that was hard red, so that farmers could grow a wheat variety that the millers wanted. However soft white wheat was still wanted by the bakers for their cookies and cakes and pastries, so special roller mills were built to handle the soft white wheat. Still for making white flour for bread, hard red wheat was the winner. Even so, not all the new hard red wheat varieties performed in bread as well as the originals.

Then came the Second World War, and all the chemical developments that resulted. This huge chemical industry was good at making explosive ammonium nitrate, and had experimented with various compounds to be use as war gases. After the war came the realization that here was a huge production capacity that was no longer being used, and which needed to be repurposed for peacetime. Ahh! There was an idea! Ammonium nitrate would make a magnificent fertilizer since it is so rich in nitrogen and easily water soluble.

Oh yes, and all those biologically active war gases could be repurposed as insecticides and fungicides, and possibly herbicides to kill weeds. So it was no wonder that Norman Borlaug in Mexico saw the potential to dramatically increase the yield from wheat. He did this by planting wheat very densely, adding plenty of this new fertilizer and generously irrigating. The problem was that the available wheat varieties grew very tall and very lushly under these circumstances and instead of yielding a huge crop they lodged, or fell over, so making them difficult to harvest. The solution dreamed up by Norman Borlaug and others was to breed for short strong-stemmed wheat, and apply herbicide to kill the weeds that would over-grow really short wheat. But the question then was where to find wheat that was really short, to make the necessary crosses? Certainly it is not easy to find naturally short wheat among the ancient landrace varieties, since previous selections by farmers were if anything in the direction of choosing the largest plants. By the 1950s we had also learned that x-rays and atomic radiation could cause mutation in plants. And sure enough this had been tried on wheat with the result that a dwarf wheat plant was produced in Japan. Borlaug used this dwarf wheat to cross with the tall plants and eventually produced short strong stemmed dwarf varieties that could be planted densely, after the use of herbicide to kill weeds, fertilized with the fast acting chemical fertilizer, irrigated thoroughly and lo and behold the yields were phenomenal, up to 3 times the precious yields. This certainly saved lives in India where they were in great need of a crop yield boost, but no attention was given to the consequences of such an agricultural regimen on the environment, or the sustainability over the long term. The result has been that this has become the norm for growing wheat. Perhaps the only concession to looking after the soil is to rotate the wheat sometimes with tomatoes here in California, or with soybeans in the Mid-West. Farmers are mesmerized by the prospect of such high yields.

The major effort to improve wheat crops currently rests almost entirely in the breeder's hands. Very little effort and money has been expended on understanding the soil conditions that would reduce disease and increase fertility. Instead there are labs that routinely test new wheat varieties, as they are developed, to make sure they conform to the needs of the white flour miller and the white flour baker. In such a system it is very hard to produce good whole grain products. The system just is not built to provide the good whole grain products that we now know to be essential to our health. Another aspect, which is devastating in our quest for whole wheat, is that the bran and germ from wheat are monetarily valuable when sold as animal feed. Meat production is highly dependent on this source of feed, for feedlot cattle, rather than pasturing the animals. In this modern conventional food system, the end products are refined flour and grain fed meat, neither of which is healthful. Such a diet basis leads to a high risk for colon cancer.

Finally now, this conventional style of agriculture has come into question. Botanists like Giles Waines have recognized that the root systems of the dwarf wheat varieties are shallow in comparison with the large roots of the original landrace varieties of wheat. Shallow rooted wheat has less ability to cope with drought and less ability to take in nutrients from the soil. Historically wheat was grown with the available rainfall, and only irrigated in regions where there was virtually no rainfall, but where the run-off from mountains could be captured. Wheat was also grown without added fertilizers. Instead, fast growing wheat was grazed down by animals, the fields were ploughed, planted and harvested with the help of animals, and the natural weeds included nitrogen fixing clovers, lupins and other similar soil enriching plants.

For vegetables we have had various organic systems presented, mostly involving composting of waste plant matter. In the end though these systems have largely addressed increasing the fertility of soil primarily for growing vegetables. The rotation of vegetable plots with large scale wheat growing and the further rotation to nitrogen fixing legumes and a cleansing brassica crop isn't happening very often. The organic systems still involve some of the soil destroying habitual processes that are inherent in the conventional system, such as disking the soil to eliminate weeds, and the addition of large amounts of fertilizer, except that in this case the fertilizer is a natural product such as composted chicken manure. The new long term realization for soil health is to leave it as undisturbed as possible and to allow well chosen crop plants to penetrate the depths, and to hold on their roots the microorganisms that will draw micronutrients from the soil. But how can we plant seed in such an environment? Until recently I was thinking solely along the lines of crop rotations to build the soil, which still demanded that we would till the soil in order to bring down the weed population and to prepare the soil to receive the seed. No-till farming seemed not to be a method that I could accommodate. However, recently I heard a talk given by Colin Seis, an Australian farmer with a vast farm and thousands of sheep to look after. His solution to building the soil and making life considerably easier for himself was to send in the sheep to graze a field before planting the wheat seed into a groove, made with a no-till seed drill. Part way through the growing season if the wheat and weeds were growing well he would send in the sheep to graze the crop down, just enough to reduce the weed competition, yet leave the wheat tall enough that it could still grow back. The logic of this was that the native grasses and weeds originally in the field were perennials, while the wheat is an annual. The annual wheat races to fruition in a season whereas once grazed down, the perennial grasses and wildflowers will grow back only slowly. Finally after the wheat is harvested, the sheep can come in again, or if poultry are available then poultry can have a feast on the grain that fell from the combine harvester. Wheat would not be grown in that field again for perhaps two years. Instead an annual legume crop such as chick peas would be grown, and perhaps a brassica oil seed crop in the other year. Certainly I know that wheat grown on organically sustained soil produces desirable high protein wheat, and when wheat is planted in depleted soil, the protein is low and the wheat is disappointing in the way it makes up into bread.

In other words wheat is not a crop to be considered in isolation. Wheat in an organic system means that a range of other foods are also produced, and each contributes to enriching and maintaining the soil integrity. Amazingly when we get this formula right we find that all the crops in the system will provide us with the variety that we have come to appreciate as the requirement for a pleasing and healthy diet. The farm can no longer be just a wheat farm but instead supports dairy animals, egg laying poultry, pasture fed meat, and a wide range of annual legumes, brassicas and other vegetables. The result is that farm income is spread beyond the wheat. The other crops and animals support the wheat in ways that do not demand the purchase of large amounts of amendments, or demand heavy irrigation. Wheat yield must certainly be reasonable but it need not be excessive to bring in enough farm income. This is of course a simplistic picture but I much prefer contemplating the management of this system, than the conventional system.

Modern wheat seed does not have the required characteristics for these new organic systems. However we are lucky to still have available in seed banks those old fashioned landrace varieties. There are a few of us around the world who are selecting and growing out climate matching wheat landraces, enough for farmers to grow them once again as crops, and there are a few breeders of wheat for modern organic systems, such as Steven Jones at the bread lab in Washington State.

But what might the ideal new system for wheat look like if we are to have organic wheat in the whole grain form for everyone?

Currently all the processing of wheat is on a massive scale in centralized centers often very distant from the cities.

First of course we'll need good wheat seed for the organic farmer to grow, on farms diverse enough to build and sustain fertile soil. Next, the farmer needs to clean and store the grain either on the farm, or not too far away, perhaps no more than 25 miles from the farm. But the major change that is needed is to have supplies of clean organic wheat grain stored locally, wherever people are living. If we have this then it will be possible for many bakers and chefs to have their own small stone mills, at the ready to prepare freshly milled whole wheat flour to bake with. Larger scale stone milling could also happen at the local grain storage centers, and the flour would be available while it is still fresh, since it is produced so locally. Here in most of California and in many other places where wheat is no longer a major crop there is little or no infrastructure such as grain cleaning and storage facilities or a distribution system for wheat. The result is that local organic wheat is difficult and expensive to produce, and will continue to be so until we have the infrastructure to efficiently manage the flow from farm to city. Luckily there are farmers, many of them young and new to farming, who are determined to build a new, local, organic, whole wheat supply. We need to support them by buying their products for our own good health, and for the good health that they will bring to our communities as they expand and build the needed infrastructure.
Thank you for listening.